

REPORTS ON

WINNIPEG 

PAVEMENTS

Abstract

	Page
Introduction	1
Winnipeg Macadam Specifications	2
“ Asphalt “ Extracts from.	4
Report of Mr. E. P. North on Stone and Specifications.. . . .	6
Report of Mr. A. W. Campbell.. . . .	11
Report of the City Engineer on Mr. Campbell's Report	26

Introduction.

As the subject of street pavements is one of great interest to the public of Winnipeg, and as the published documents and statements relative to it are difficult to procure, it has occurred to the undersigned that these reports, collected and published in pamphlet form, would be useful to those interested in the matter and would assist the public, in view of the agitation now being raised, to understand what has been done and the present position of our street improvements.

While admitting that our macadam has not been a perfect success as a pavement, I think it has come up, fully, to the expectations of those who, understanding the difficulties against which it had to contend, advocated its use. Its cost has been very reasonable, and its improvement, as extensions of pavement take place, is very apparent to those who use the streets.

The construction of macadam has been in accordance with the most modern and approved methods; and the best material at hand has been used.

The report of Mr. E. P. North, of New York, Vice-President of the American Society of Civil Engineers, a well-known author and expert on macadam road construction, bears out this contention.

It is to be regretted that Mr. A. W. Campbell, Road Commissioner of Ontario, who made a flying visit here some months ago, and who has now sent in a report on the lines indicated when he was here, had not made a deeper study of and obtained more reliable information with reference to the matter.

In the Annual Report of the City Engineer for 1898 I say:

"To ensure the success and permanency of macadam pavements, they should be protected from the sticky mud of unpaved streets and lanes. It is clear that this can be done only by covering all the streets and lanes in the thickly built up portions of the City. The streets are being paved as fast as can reasonably be expected. No provision has, however, been made, except in some special cases, to pave the lanes."

The same remarks, though not to so great an extent, apply to-day.

H. N. RUTTAN,
City Engineer.

Winnipeg, 20th Nov., 1900.

Winnipeg Macadam Specifications.

Specification for Macadam Pavement.

Contractors may tender for any or all of the streets.

Streets shall be graded to levels and lines to be given by the Engineer.

After grading, the surface for pavements shall be consolidated by rolling with a roller to be furnished by the City. The contractor to be charged with the cost of running the roller, which cost shall be determined by the City Engineer.

The rolling shall be of such duration as may from time to time be determined by the Engineer.

Any surplus earth is to be hauled, disposed of and levelled off at places and in manner satisfactory to the Engineer.

Drains shall be cut at the sides of the roadways from 12 inches to 18 inches in depth below the graded surface.

The drains shall be graded to catch-basins or side ditches, and connected with them by 6-inch vitrified pipe or by box drains, as the Engineer may require.

The drains shall be filled with large screened gravel or broken stone. If gravel, no stone to be less than $\frac{1}{2}$ inch in diameter.

Cross-drains shall be cut 100 feet apart on street to connect with side drains, and shall be filled with stone.

Gutters shall be formed 4 inches to 8 inches in width at the outside of the macadam. They shall be constructed of selected blocks of limestone not less than 8 inches or more than 2 feet in length, and not less than 6 inches in depth, on a bed of gravel 6 inches deep. Surface of gutter stones to be self-face or bed of the stone, back to fit up to the curb blocks as well as selected stones will admit of without dressing—ends of stones to be roughly squared. If required by the City Engineer, gutter stones shall be replaced by broken stone.

On the prepared foundation shall be laid a course of broken stone, which, when broken and rolled, shall be 7 inches in depth at the centre, diminishing to 5 inches at the sides. The stone for this course shall be hard limestone or other rock of satisfactory quality, clean and free from dust; the stones shall, as nearly as possible, approach a cube in form,

and shall be in size such that they will pass through a $2\frac{1}{2}$ -inch ring.

The stone shall be raked into an even layer, and shall then be rolled until the whole is thoroughly consolidated and brought to a smooth and even surface.

The rolling shall be continued until the stone has stopped settling and is of an even surface; if any settlement occurs, fresh stone shall be added, and when the rolling has been completed, the stone shall be at the exact grade determined upon for the surface of the layer in question.

The surface stone shall be laid, rolled and deficiency caused by settlement shall be made up in the same way. The contractor must determine what extra allowance he shall make for settlement, as he will be paid on surface measurement only.

The second course of hard hornblendic schist rock of satisfactory quality shall be 3 inches in depth; it shall consist of stones $1\frac{1}{2}$ inches and under in size, and shall be thoroughly rolled, as specified for the first course.

After thorough consolidation, this course shall be covered with fine limestone screenings, or sand and gravel, which shall be thoroughly rolled into the interstices. When the pavement is completed, $\frac{1}{2}$ inch of fine screened gravel is to remain on the surface. The watering and rolling to be continued till the street is of smooth surface and watertight.

Curbing is to be formed of limestone to plans provided. Length of blocks to be not less than 1 foot, thickness 6 inches, and depth not less than 10 inches. Blocks at curved corners to be of selected stones of not more than 1 foot in length, finished same as the straight blocks. The curb shall be backed with earth, levelled and graded.

Stone will be supplied by the City to the contractor, and the contractor shall take the same. It will be charged as follows:—

Curb stone, per lineal foot, on street	\$0.18
Broken limestone, per cubic yard, on cars here	1.10
Broken hard stone, per cubic yard, in crusher bins here. .	3.25
Gutter stone, undressed, per cubic yard, on cars here . . .	2.75

Contractors to tender for the work complete, City supplying and delivering stone as above. Separate forms of tender are provided. In each case contractor is to state a price for the work complete.

Extract from Asphalt Pavement Specification.

Specification for Railway Track.

A trench is to be graded to the depth of the gravel ballast from finished surface, and the width shown on the detail plan.

A cross trench is to be graded at every 100 feet, from the track trench to the curb trench at each side of the street. This trench will average 9 inches in depth, 8 inches wide, and is to be filled with gravel or broken stone. (Note: In addition to this drainage, 4-inch tiles were laid between the rails of each track and connected with the sewer manholes.)

The ballasting is to be of clean, sharp sand and gravel.

The Electric Street Railway Co. will provide any additional iron work required, also ties and paving bricks or scoria blocks.

The existing rails are to be taken up and relaid in position and at levels as laid out by the City Engineer. The contractor to do all work in connection with the track laying (except electrical bonding, which will be done by the Street Railway Co.) in a manner satisfactory to the City Engineer. All old stringers and other material connected with the track to remain the property of the Street Railway Co., the contractor to remove and pile same at the Company's depot.

After the rails are laid, a concrete, of the same kind and made in the same manner as described in the specification for asphalt foundation, is to be laid between the ties, ties being laid at 2 feet centres. The concrete is to be the full depth of the ties, 6 inches. The concrete is to be struck off with a straight edge to a true and even surface, flush with the surface of the ties.

After the concrete is, in the opinion of the City Engineer, sufficiently set, a layer of clean sharp sand is to be laid thereon, and brought to a line parallel with the intended contour of the finished pavement. To insure correctness of this line, wooden templates of the requisite shape and camber are to be used at distances of say 10 feet apart, the sand being

struck off flush by a straight edge and rolled with an approved hand roller.

The pavement blocks (scoria or vitrified bricks, as may be decided by the Winnipeg Electric Street Railway Co.) are to be laid immediately after the sanding.

The pavement blocks are to be laid quite close "block and block" in lines at right angles to the rails between the same, and lengthwise parallel with the rails outside the same. At the outside of rails the blocks will be laid close to the table of the rail; inside the rails a space of $1\frac{1}{2}$ inches is to be left between the bricks and the table of the rails.

The courses of blocks must break joints at least 3 inches, and each course must be tightened up; no parts of bricks being allowed except such as may be required for closers.

A wooden screed 2x6 inches is to be laid outside the course of bricks at outside of rails to hold them in place until the asphalt is laid.

The $1\frac{1}{2}$ inch spaces are to be filled in up to $\frac{1}{2}$ inch below rail level with cement grout, as described hereafter, outside the rails; the space between web and bricks is to be flushed up with the cement mortar described in asphalt specifications.

The blocks are to be carefully beaten down upon the sand with square, wooden-faced beaters of not less than 12x12 inches surface, to the exact form of cross-section and camber required, any irregularities to be remedied by taking out or filling in sand as may be required.

When the surface is of form satisfactory to the Engineer, a cement grouting composed of one part of approved quality of Portland cement and three parts of clean, sharp sand shall be poured over the surface and immediately brushed into the grooves and joints with suitable cane brooms. The grouting is to be filled in "twice," the first filling up to about one-half the depth of the blocks, the next up to the surface.

The manner of mixing and applying the grouting is to be subject to the approval of the City Engineer.

As portions of the pavement are grouted to the satisfaction of the City Engineer, a layer of sand not less than $\frac{1}{2}$ inch in thickness is to be spread over the whole surface of the pavement.

Such portions of the pavement when completed are to be kept closed against traffic for at least four days, or such longer period as may be required by the City Engineer.

Report of Mr. North on Stone and Specification.

(Copy.)

City Engineer's Office,

Winnipeg, Man., 16th July, 1900.

E. P. North, Esq., C.E.,

V. P. Am. Soc. C. E.,

220 West 57th Street,

New York, N. Y.

Dear Sir,—

I am instructed by the Council of the City of Winnipeg to forward you samples of stone, and to request you to let us know your opinion of them for macadamizing purposes.

The limestone costs \$1.15 per cubic yard and the trap \$2.75 per cubic yard, both loaded on wagons at the track. We would like your opinion:

1st. As to the suitability of each kind of stone for the work specified.

2nd. As to the suitability of the trap rock for the surface of macadam streets, taking into consideration its wearing and binding qualities.

3rd. As to the use of trap for wearing surface, and as to whether, considering its extra cost, such use is justified.

I also enclose our general specification for macadam. We will be glad to have you make any suggestions that occur to you in connection with it.

Samples of the stone referred to have been sent to you by parcel post.

Yours truly,

H. N. RUTTAN.

City Engineer.

(Copy.)

No. 220 West 57th Street, New York,
July 26th, 1900.

Mr. H. N. Ruttan,
City Engineer of Winnipeg.

Dear Sir,—

Your esteemed favor of the 16th inst., with enclosure and bag of macadam samples, is at hand. The stones have been examined physically and the specifications read.

I take the liberty to so extend the permission given to make suggestions as to the specifications, that they cover the whole subject. The limestone costs but about 42 per cent. of the trap or hornblendic shale, and there would be a saving of about 33 per cent. in the cost of compacting it; on the other hand, it is not tough, and is smooth—that is, it will neither wear long nor bind well, and the dust from it will be acrid, injuring goods in shops and furniture in houses, if it is laid in business and residence streets. This last mentioned objection, however, does not apply with much force to country roads, where limestone dust of this quality merely troubles travellers.

As the value of a road increases somewhat with the $1\frac{4}{10}$ power of its length, and very slightly with its depth, so it is thick enough not to break through, how would it do as a temporary measure to try the first layer, 7 and 5 inches, for a year or so? The trouble from dust may be ameliorated as hereafter proposed, and you could pave more than twice as much street for the same appropriation. If you have a heavy clay soil and are fearful of the effects of frost, let me advise you strongly to first lay down 3 or 4 inches of fine sand, dust from the stone breaker, old plastering, or any other material that will keep the clay from working up through it to lubricate the stones. All understand that the top surface of a macadam road should be a roof, but it is not so generally conceded that in some soils a roof on the underside against wet clay is fully as necessary.

Limestone dust can be kept down, and without injuring the road, by adding clay and fine gravel after the stones are thoroughly compacted and the interstices filled. Between one-eighth and one-quarter of an inch when compacted of

clay, free from quicksand, should be added and rolled once to make a smooth surface, then add one-fourth to three-eighths of an inch of fine gravel or strong and coarse sand, and the whole rolled with water, and re-rolled just as it is drying out. If you can command the services of watering carts you can keep the dust down at a much less expense than with limestone on the surface, as the clay will hold moisture longer than the limestone, and with proper maintenance you will have a tender but delightful road.

If the clay is laid on before the surface is compacted and filled, or in lenticular masses, and the gravel spread from the wagons, this plan will not be valuable.

The hornblendic schist seems a valuable stone. My only doubt about it is that one of the specimens shows a tendency to cleavage cracks. On this account, if there is enough of like material to make it an important factor, it might be advisable to keep as much of the broken stone between $1\frac{1}{2}$ and 2 inches as is practicable, if there is much heavy hauling on the streets.

The stone is hard and will bind well, so that the cost of maintenance should be small. There will be dust from it, but the dust will not be notably injurious to either colors or fabrics. Except in the item of cost it seems in every respect preferable to the limestone.

Your letter asks about trap. The samples sent are not trap, as the term is understood here. The stone submitted will not bind as well as the Hudson River trap, nor wear as well. I have written on the assumption that the trap of your letter and the hornblendic schist of the specifications were synonymous terms.

Regarding the specifications. I think you would have a somewhat better road if it was filled with screenings of the hornblendic schist, but as a large part of the cost of that stone is probably transportation, and the screenings might cost about as much as the broken stone, it may be doubted if the substitution would pay; otherwise I have no suggestions to make.

Answering your questions :—

1st. The hornblendic schist seems a suitable stone for macadam, either in town or country, as it is hard, not very brittle and will bind well. The limestone seems not good of its kind, and for reasons mentioned above, it has no advan-

tage, except its cheapness; countervailing which is the greater cost of maintenance.

2nd. The sample of rock sent to me, a hornblendic schist, seems to be a better stone than the average used for macadam. It is not so strong and tough as either Hudson River trap or Guernsey granite. It will not bind as well as Hudson River trap, but I think it will bind better than the Guernsey granite.

3rd. The advantages of your stone are covered above. The selection made must be governed by comparing the money available, both at present and in the approximate future, with the length of roads or streets to be macadamized, points on which I am not informed.

Yours truly,

(Signed) EDWARD P. NORTH,

Mem. Am. Soc. C. E.

(Copy.)

Office of the City Engineer,
Winnipeg, Man., 3rd August, 1900.

The Chairman and Committee on Works.

Gentlemen,—

I enclose herewith report of Mr. E. P. North, Vice-Pres. Am. Soc. C. E., on our macadam pavement.

The following are the estimated costs of the different kinds of street spoken of per square yard, taking the cost of our present street at $77\frac{1}{2}$ c.

One layer of limestone 5 inches at sides, 7 inches in centre, with 3 inches of sand or stone screenings under, 60c.

Present specification, $77\frac{1}{2}$ c.

Present specification with addition of 3 inches sand or stone screenings under, 90c.

Experience has not shown that the under layer of sand or stone screenings is necessary for the pavement as now constructed. It, no doubt, would be necessary if the top layer were reduced to 5 and 7 inches.

With reference to Mr. North's recommendation that the road be filled with screenings of hornblendic schist: As the stone is crushed here the screenings are used for this purpose. Of course Mr. North did not know this.

I enclose a copy of my letter to Mr. North and one of our specifications.

Your obedient servant,

(Signed) H. N. RUTTAN,
City Engineer.

Report of Mr. A. W. Campbell.

To the Chairman and Members of the Public Works Committee of the Council of the City of Winnipeg.

Gentlemen,—

In response to your letter from your Chairman to the Honorable, the Premier of Ontario, asking that I be permitted to visit Winnipeg for the purpose of consulting with you in the matter of street improvement, it was my privilege to visit your City, and in compliance with your request, I beg to submit the following report:—

In company with your Committee and City Engineer, I looked over the City, studied the improvements being made in its rapid development, considered its location and surroundings, so as to judge somewhat of future requirements, that I might suggest the pavements that will be consistent with the City's demands. I made an examination of the natural material available for street improvement in the vicinity of the City; the manner and methods of preparing this material and applying it to the streets; the nature of the soil and facilities for drainage. I observed the different classes of pavement being used and the manner in which they have been laid; the traffic of the City; its trend, concentration, and distribution over the streets.

In every particular it appears to be the aim of your authorities and the citizens to provide the most durable and substantial class of improvements within reasonable limit of cost; and they are building not only for the present, but for future requirements. In public buildings, places of business and residences, modern design and good workmanship have been employed. In the matter of street improvement it does not appear as if the same study, care and economy have been practiced; but, on the contrary, much inferior and unprofitable work has been done, and I would suggest that the question of street improvement, which is possibly the most important public work with which your City has now to deal, should be given very much closer attention. Business me-

thods should be employed, a plan of the City should be prepared, levels taken and grades established, the streets should be classified according to the requirements of traffic, specifying the most suitable class of pavement for each, careful plans and specifications for the different kinds of pavements should be prepared in accordance with the most modern practice, the best methods of their respective kinds should be employed, skilled overseers should be engaged, and every precaution taken to secure the most perfect results for every dollar of expenditure. Expenditure can be made no more profitable to the ratepayers than on street improvement, and there is no public work that receives less genuine consideration, and upon which there is more carelessness displayed.

Street-making, unfortunately, is looked upon as being a very commonplace problem. It is considered that any work done must be an improvement, that little skill or study is required in connection with the work, that a certain amount of money is required every year for making repairs, that it is part of the municipal tax which the people must provide annually, and from which little can be expected. In nearly every municipality an examination of the expenditure reveals to the people that streets and sidewalks, at best, are expensive public works to maintain, and the expense is much increased when the work is improperly done.

In many places, by a judicious expenditure on temporary work, where the soil is favorable, much good results, but in Winnipeg this is a difficult and almost hopeless task, owing to the peculiar nature of the soil, so that any effort to maintain your earth streets should be of the very simplest kind, and substantial work should be aimed at as far as possible.

This soil, however, when dry, is strong, and makes a pleasant road, supports traffic and resists wear to a remarkable degree, and in the substantial improvement of your street one point to be closely observed is to drain this foundation material and keep it dry, for when thus treated no better foundation for pavements could be had. Without providing a system that will thoroughly drain and keep drained this natural soil, it will be impossible to make good streets. And it is surprising to find that you have not given more attention to this important principle.

Your citizens are evidently alive to the importance of good streets, and have shown a commendable spirit in adopting pavements creditable to the City, and when the width of your streets and the great cost of the higher classed pave-

ments is considered, it is at once apparent that your people are anxious for the best. That you should have adopted asphalt, wood and macadam, is an indication that your ideas are along the right line, but on examining your work it is clear that these ideas have not been carried into successful practice. The people are not receiving what they should reasonably hope for from their liberal expenditure. In their anxiety to get out of the mud, almost any kind of pavement may at first seem an improvement, yet the effect of inferior work will dampen their enthusiasm. Expensive repairs and reconstruction following, will prove disappointing and burdensome. They have a right to expect better results.

The cedar blocks have been laid in the usual way, and so far as this kind of pavement is useful, have given very good service. In laying asphalt, much skill and care are required, and a full knowledge of how the material should be prepared and laid. Where street railway tracks have to be dealt with, the result of the experience of other places should be consulted. To secure an even and uniform surface, the foundation must be thoroughly drained. The present appearance of the asphalt pavement indicates that you are commencing where other cities have ceased to experiment. In laying of this very sensitive and costly pavement, drainage has been overlooked. Asphalt has been laid up to and between the rails of the street railway, a practice which experience has discredited.

During the last few years a great many streets were treated with broken stone. These were chiefly residential streets, and your plan of narrowing the roadways, boulevarding, sodding and placing sidewalks, is in accordance with modern practice, and has added very much to the appearance of the property, the streets, and the City generally. This class of work should be encouraged. The roadway has been excavated and prepared in much the usual way, and broken stone has been used as the paving material. But the roadway is in many respects a striking exhibition of bad workmanship and improper methods. No proper foundation has been provided by drainage, much material has been used that is not worth hauling. Few of the streets are sufficiently crowned, many are irregularly crowned, and in places the surface is flat rather than crowned. Insufficient material has been used, and this has not been properly bonded. The principles of proper construction have not been observed in placing the materials. The base of the pavement is soft stone,

the surface a hard stone crust, and the work while new, and in dry season, presents a fairly good appearance, but in wet weather, owing to the undrained foundation and soft stone base, under traffic, will settle, rut, and lose its crown, material will be picked up by muddy wheels, holes and depressions will be formed, and extensive and costly repairs will be necessary. There are many small places in Ontario, such as Renfrew, Smith's Falls, Perth, Cornwall, Brockville, Belleville, Peterborough, Barrie, Galt, Berlin, Owen Sound, Welland, St. Thomas and Stratford, that would afford you profitable object lessons in how this particular class of pavement should be laid, and this is true of even smaller places. In a place the size and ambition of Winnipeg, with your means and equipment, it is regrettable to find such faulty work carried on so extensively. The short life and imperfect service of these pavements, the cost of repairs and maintenance, will make them very expensive and unsatisfactory. The building of a good macadam street is a simple process, and with all the implements necessary for good work in the hands of your authorities, I can see no reasonable excuse for this treatment of those citizens, who, with so much loyalty for the City's interest, have pledged themselves to pay for the work.

A first-class quality of material for making macadam roads is not to be found in the vicinity. The limestone at the City quarry is of two grades, the upper and lower formations. The lower formation is so soft as to be useless for any part of the work. Unfortunately, this has been used largely in the work of the past few years. The Council, I understand, has passed an order prohibiting its future use, which was a commendable step. The upper formation is of a much harder and tougher quality, and when properly prepared by crushing and screening, and applying according to correct principles, will make a serviceable and cheap pavement. The crushing plant in the quarry seems to be an ideal equipment and does its work admirably, preparing the material at a very reasonable cost. A large quantity of gravel is to be found a few miles east of the City, and on some of the lightly travelled streets this material could be used to advantage in making what might be called gravel pavements. If a crusher were placed in the pit and the material passed through, breaking the stones into cubic fragments, grading them and by screens eliminating the sand and dirt, a quality of stone superior to that in the quarry would be provided. A considerable quantity of hornblende schist has been

brought by rail from the vicinity of Rat Portage, and used as a light surface coating. This is not a first-class road material. It is not worth what it cost the City. If material is to be brought by train for a long distance, granite and trap rock, which can be secured in large quantities in Northern Ontario, would prove a more profitable investment.

Artificial stone walks are being laid. This material should take the place of plank as rapidly as they are being renewed. In laying these walks, porous tile, about 4 inches in diameter, should be laid in the foundation to prevent the frost from distorting the walk, and in time leaving an uneven surface. The omission of these tiles and a lack of a stable foundation is now noticeable on some of the walks already laid, and the injury will increase. The laying of these drains is not an expensive work, being about 4 cents per lineal foot, and is a very valuable security to the efficiency of the work.

Classifying the streets and determining the pavement for each is a matter of very great importance. A well laid gravel roadway costing 50 cents per square yard may be just as serviceable and as efficient on an outlying street as an asphalt pavement costing \$3.00 a yard would be in the central part of the City. But these again, if interchanged, would be entirely out of keeping with the traffic and surroundings. A classification, wisely made, would tend to secure suitable pavements throughout the City, and would influence the ratepayers in petitioning for such improvements. If, however, they should desire and are willing to pay for a more costly pavement, it could be granted.

In classifying streets and determining the pavement for each, many things must be taken into consideration in order to make them harmonize with the locality, requirements of traffic, assessed value of the property, etc. This matter requires careful consideration.

QUALITIES OF PAVEMENTS.

The desirable qualities of a pavement are :—

1. That it afford a pleasant and secure footing for horses.
2. That it be smooth, so as to render travelling and traction agreeable, easy and noiseless.
3. That it present a good appearance.

4. That it be sanitary; the form and material such that it will be impervious, liquids will not have permanent lodgment and dust will not be easily produced.

5. That it be economical, the durability and service rendered commensurate with the cost of construction and repair.

6. That it be of easy repair, of removal and replacement at a reasonable cost, and with appliances and materials within the control of the municipality.

In view of the foregoing it becomes apparent that an ideal pavement material has not yet been discovered.

Of the pavements commonly used, asphalt, vitrified brick, stone setts, cedar blocks, scoria block, broken stone (macadam), gravel, none are capable of general or even special application, filling all the above conditions, but each possessing merits making it most suitable for streets of a certain class.

Asphalt is a material most suitable for business streets, occupied by retail stores and offices, and, indeed, for all business streets, except purely wholesale sections where slow, rough and very heavy traffic is concentrated, upon which latter, granite setts should be laid. Asphalt, of course, may be used on residential streets, but it is too expensive and does not possess as many desirable qualities for such streets as does first-class macadam properly laid and maintained. Vitrified brick pavements are suitable for many business streets subjected to slow, steady and not very heavy traffic, or to moderate traffic. Owing to its noisiness it is not desirable for residential streets or streets subjected to light, frequent and rapid travel. Excepting where asphalt, stone setts, or vitrified brick are necessary or advisable, broken stone (macadam) should be the standard pavement for streets generally. Cedar blocks should be discarded.

ASPHALT.

With cement concrete sidewalks, stone curbing, and a roadway surfaced with asphalt, a little is left to be desired in the design of a street, so far as it is now possible to reach the ideal. If there is an electric railway on the street, paving blocks or paving bricks should be placed between and adjacent to the rails, as the vibration caused by heavy street cars is very destructive to asphalt.

While much is to be said in favor of asphalt, it is not to be considered faultless. It does not afford a good footing for horses, it is dusty, it is difficult to repair, or to relay after the street has been excavated for the purpose of laying sewer connections, gas or water services. It is expensive, and for that reason alone, is not very acceptable, except where property is of a proportionate value.

The materials of which asphalt pavements are composed may be either natural or artificial. Natural asphalt is obtained by grinding to powder bituminous limestone found in Texas, Utah and elsewhere, or the bituminous sandstones found in California, Kentucky, Texas, etc. This powder is then heated until soft and is spread while hot on the roadway. The chief source of artificial asphalt is the Island of Trinidad, W.I., where crude asphaltum is obtained. This is refined and mixed with sand and stone dust; is heated and applied to the roadway. The artificial roadway pavement is composed of about 90 per cent. sand and 10 per cent. bitumen, so that the quality of sand used is nearly as important as that of the asphalt proper, and with the abundance of first-class sand at Bird's Hill, No. A 1 pavement of this material should be laid. Underneath the surface layer, which should be about 2 inches thick, should be a foundation bed of concrete 6 inches in thickness. A 4-inch base will be found too light for the traffic of such streets as Portage Avenue and Main Street.

Owing to the skilled labor and machinery needed in laying this pavement, it is found most satisfactory to have it laid and kept in repair by contract. When properly laid, its durability cannot be questioned, but there is some difficulty in surrounding a contract with such safeguards as will ensure first-class material and workmanship. A reliable company should be employed and the maintenance of the pavement guaranteed for fifteen years, which is its estimated life. A common guarantee is for a term of five years, but this is not sufficient. Breaks in asphalt pavements must be immediately repaired, otherwise moisture enters, causing rapid decay.

VITRIFIED BRICKS.

Vitrified bricks are different in composition and manufacture from ordinary building brick. They are made from clay, shale, or a mixture of the two, which is heated to the

point of vitrification and then slowly and gradually cooled. The size of each brick is about $2\frac{1}{2} \times 8\frac{1}{2}$ inches. The durability is not equal to that of asphalt or stone blocks, but they are less noisy than stone blocks. They are manufactured at Toronto, in the State of Ohio, New York, Pennsylvania and elsewhere. There is room for much variation in the quality of brick. The process of manufacture is one which requires an expensive plant and much skill in burning. In laying a vitrified brick pavement, the natural earth is first prepared by draining, grading and rolling with a steam roller. On this a layer of concrete is laid, 6 inches in thickness, and in this the bricks are embedded. They are laid on edge in courses at right angles to the street line, and with broken joints, the joints being cemented or "grouted."

STONE SETTS.

Stone setts, or blocks, form one of the oldest paving materials, is extensively used in cities, and is the strongest and most durable that can be had. It is well adapted to steep grades up to 10 per cent. (which fortunately do not exist in Winnipeg), requires little repairs, and suits all classes of traffic. It is, however, very noisy and is rough. It is, therefore, not suited to residence streets, or business streets where there are retail stores. It is best adapted to streets occupied by wholesale houses, in which there is much slow and heavy traffic. Stone blocks are also suitable for paving between street railway tracks. The stone generally used is granite or trap, which few cities can find in their own locality, and in this respect the cost of bringing it from Northern Ontario would be no greater for Winnipeg than for Toronto. The stone should be cut into rectangular blocks about 7 inches deep, 3 inches wide, and 9 inches long. The price paid for quarrying and making these blocks will average \$30 per thousand. In constructing the pavement, they are laid on concrete base in much the same manner as vitrified bricks.

BROKEN STONE (MACADAM).

The crushing plant which you have, properly prepares and grades the stone for this class of pavement, but instead of the present practice of applying it to the street, the following will indicate proper methods.

Excavate the road-bed to the required dimensions, giv-

ing the sub-grade a uniform crown, 7 inches higher in the centre than at the sides. Lay a row of 5-inch porous tile in the road-bed 2 feet from each of the curb lines, and parallel with them, these tiles to be laid 2 feet beneath the sub-grade and have a regular and uniform fall into the catch-basins or outlets. Lay lateral drains of porous tile 4 inches in diameter, extending diagonally into the roadway, at an angle of 45 degrees with the side drains, these drains to be at intervals of 50 feet. Make the trenches to receive the tiles as narrow as possible and fill them with coarse gravel, the surface of the sub-grade to be rolled until it is thoroughly compacted. During the process of rolling, fill any settlement or depression with gravel or other suitable material. Place the kerbing at each side of the roadway in the usual manner.

On the sub-grade thus prepared, place a single layer of flake stone about 5 inches in thickness. This stone is to be laid as closely as possible and the openings between them carefully filled with stone chips or coarse broken stone; upon this and over the flake stone place a layer of the coarsest broken stone now being produced by the crusher, 7 inches deep in the centre and 5 inches deep at the curb, and sprinkle upon it the fine stone screenings until all the voids are filled. Sprinkle this layer with water from the watering cart, and by the use of a harrow work the fine screening into a mass. Pass a roller over it three times. Upon this place a layer 2 inches in depth of the intermediate grade of crushed stone. Apply fine screening and sprinkle as above specified, over this place a single layer of the third grade of crushed stone, and cover with screenings until all the voids are filled. Then sprinkle and harrow as above specified, adding the fine screenings until all the voids are filled, and sprinkle and roll until the mass is thoroughly consolidated and the surface made hard and smooth.

While the rolling of the finishing surface is in progress, the material should be kept moist by sprinkling, but not wet, and in no case should sufficient water be used to reach the sub-soil foundation.

DRAINAGE.

One of the most serious defects in the streets of Winnipeg, owing to the nature of the soil, is the lack of drainage. Good pavements are largely a matter of good drainage. Not that the shape of the roadway, the material of which the sur-

face is composed, or the way in which it is laid, are unimportant, but that these are very largely a part of a system of drainage. Underdrainage is one of the first points to consider. It is the native soil which must really support the weight of traffic, no matter what material is used to form the surface. Gravel, stone, brick or asphalt are not sufficiently strong to bridge over a wet and yielding sub-soil. If this natural soil is kept in a dry state, it can support any weight, and to this end underdrainage is necessary. Underdrains may be made of common field tile, 4 inches in diameter, placed on each side of the carriage-way, underneath the gutters, at a depth of about three feet. This "lowers the water-line" and secures a good foundation.

There must be surface drainage, and for this the surface must be crowned, or rounded up, covered with a hard surface metal, and open gutters provided to carry away this surface water. The surface metal (gravel, broken stone, or other material) resists wear so that the surface of the road remains smooth, permitting the water to flow readily to the sides of the road. But a further object to be attained by the surface covering is to have a coating that will not allow water to pass through to the natural soil beneath. By crowning the surface, rolling it to make it compact and smooth, water will be at once shed to the open gutters at the side of the roadway.

A great many of the macadam streets in Winnipeg are too flat to properly drain the road surface. Roads must be sufficiently crowned, must be given a sufficient camber, to shed the water from the centre to the sides, where it may be carried in the gutters to a proper outlet. Nor should depressions or ruts be allowed to exist in the road to interfere to any extent with this surface drainage. The real secret of good streets is good drainage, and good drainage is obtained by removing all surface and sub-soil water as quickly as possible, before it can soften either the surface or foundation. For this purpose catch-basins should be placed at shorter intervals than at present, so as to discharge the water quickly and in small quantities.

Gutters and underdrains are useless, unless outlets are provided, and care must be taken to see these do not become obstructed. On Spadina Avenue and Portage Avenue and, in fact, most of the recently improved streets, the catch basins were left in the former ditches and water channels. The narrowing of the roadway has left them some distance from

the new gutters. They are now connected with the gutters by perishable timber boxes. While the work of street improvement is in progress, these basins should be removed to their proper location in the gutter, and grated. If the present form of connection is to be retained, they at least should be made of vitrified tile properly protected at the inlet.

TAR MACADAM.

Tar macadam is a comparatively little known form of pavement in Canada, although it has been used in England for some years, also in a few towns of the United States. Hamilton, Ontario, is the only city in Canada to adopt this form of pavement generally, and is now spending about \$150,000 on this work. The addition of tar renders the pavement less impervious to moisture and prevents mud and dust. It is easily repaired, and requires less scraping than does ordinary macadam. Its durability surpasses that of ordinary macadam, and the additional cost is about 15c. per square yard. With a soft porous stone such as your limestone, the use of tar would be a decided improvement, as it would add very much to the life of your broken stone pavements.

The method of construction is, in the preliminary steps, similar to ordinary macadam. The last two layers only of broken stone, together with a top dressing of fine material, being treated with tar. The process of saturating the stone with tar is a simple one. The stone is first allowed to become thoroughly dry in the sun. The tar is heated in cauldrons close to the work. The mixing is done on a plank platform. While the boiling tar is being applied, the stone is turned and returned with shovels in a manner similar to concrete mixing. The mixture is then carried in wheelbarrows to the work, spread to the desired thickness, and each layer rolled. On the surface of the tarred stone is spread a 1-inch surface of tarred gravel and fine crushed stone, which is rolled to a hard finish. A light color may be obtained by sprinkling a light coating of cement, as with an asphalt pavement.

CEDAR BLOCKS.

Cedar blocks have been used in Winnipeg with as little satisfaction as elsewhere. They were probably as cheap a

material as could have been adopted, but they decay rapidly, become offensive and unsanitary. The surface quickly roughens, so that the life of this pavement in which good service is rendered is such that a renewal is necessary in from five to seven years. If retained longer than this they become a source of annoyance and a discredit to the City. The quality of cedar obtainable is becoming less sound and more expensive, so that it is not likely that these pavements will be as satisfactory in the future as in the past.

GRAVEL PAVEMENTS.

The cost of pavements varies with many circumstances, so that a fixed scale of prices cannot be laid down, but the condition being much similar, the prices prevailing in Toronto should be a fair estimate of the cost in Winnipeg. Heavy asphalt, in Toronto, with 6-inch concrete base and a ten years' guarantee, costs \$2.80 per square yard. The repairs for the succeeding five years, the asphalt cost 30c. per square yard. At the end of fifteen years the asphalt surface can be renewed in the old concrete base for \$1.70 per square yard. Light asphalt, with five years' guarantee, will average \$2.30 per square yard. To maintain this for the succeeding ten years will cost 40c. per square yard, at the end of which term it may be renewed on the old concrete base for \$1.50 per square yard. Vitrified brick, on 4 inches of concrete, costs \$1.80 per square yard. During a term of fifteen years it will cost about 30c. per square yard for repairs. At the end of fifteen years it will require re-bricking at about \$1.20 a square yard. Broken stone (macadam) roadways cost in Toronto about 90c. per square yard, but in Winnipeg, owing to the accessibility of the stone, the cost should not exceed 80c. per square yard. The gravel roadways, as recommended, would cost about 60 cents a square yard. In fifteen years, with proper care, macadam roadways should be as good as new with an outlay during that term equal to the original cost.

Tar macadam, costing from 80c. to \$1.00 a square yard, will probably come under the same rule. Granite setts and scoria block on concrete cost about \$4.00 a square yard, should require no repairs in fifteen years, and at the end of that time be in good condition.

ROLLING.

A steam roller has been used on the streets of Winnipeg, but not in such a way as to produce the best results. The roller should be liberally used on the natural sub-soil to thoroughly harden and consolidate it before any stone is applied. The sub-soil should, before any stone is applied, be brought to a constant grade by filling with earth or gravel wherever depressions are made by the roller. That insufficient attention has been paid to the sub-grade is evident from the undulating surface of most of the roadways. An essential of all roads and pavements is a hard and compact foundation, and to secure this, thorough rolling, together with drainage, is necessary. On most of your stone roads the material used in the foundation is too soft to permit rolling, and on other streets, such as Clarke Street, Ellice Street, Francis Street, Gertie Street, Adelaide Street, recently paved, the stone, instead of being thoroughly incorporated, bonded and made stable and impervious to water by rolling, is so loose as to permit of its being readily rutted by wheels, disturbed by horses' feet and will allow water to enter the roadway instead of being shed to the gutter, which is a serious defect.

SCRAPING, SWEEPING AND SPRINKLING.

It is a mistake to provide for the original cost of pavements without at the same time insuring the investment by providing for their proper care and maintenance. If an asphalt pavement is allowed to go uncared for, in a very short time an accumulation of dirt, brought on by traffic and other means, will make it discreditable. But where these high-class pavements are laid, provision is always made for scraping, sweeping and sprinkling, so that their best qualities are always fully appreciated. But the cheaper class of pavements, such as macadam and gravel, are generally neglected and, in consequence, wrongly condemned. Quite as much (often more) mud and filth from outside sources is carried to a macadam or gravel roadway as to asphalt, and to realize the most from the investment, similar attention, though not so constant, should be given. Three or four times during the summer season should these streets be swept with a revolving sweeper. In the spring and fall, gutters and catch-basins should be scraped and cleaned. During the dry season sprinkling will lay the dust and lessen the wear.

A STREET DEPARTMENT.

As part of its municipal administration, Winnipeg should have a well organized and fully equipped Street Department, in charge of a live and experienced street commissioner. The duties of such an official should be the supervision of all work of construction on streets and sidewalks, their sprinkling, cleaning and repair; the most important part of these functions to be careful supervision of all work under construction.

While there are general principles underlying the whole question of street building, which are applicable to all pavements, each requires, in certain respects, a treatment peculiarly its own. If the best results in all cases are to be obtained, the same skill and care must be applied to the cheap as to the expensive. The best materials must be obtained and carefully prepared, and in their handling and placing in the structure, precision and exactness in following the different steps are imperative. The most perfect plan and specification may be provided by the City Engineer, but unless the man directing that work is capable of seeing, and does see, that the true intention of the specification is carried out in detail, imperfect work must be expected.

Many pavements have been condemned, not for any fault of their own, but on account of their being chosen to perform a service for which they were never intended, and oftener on account of their being imperfectly made. The question is one which requires much study and foresight and belongs to the work of an expert. He should inspect all the material employed and closely supervise the work during construction.

Winnipeg has reached that period in its history when temporary work and incapable methods with regard to streets can no longer be afforded. In order to meet the rapidly growing demands, much substantial and costly work must be undertaken, and the wisdom and economy of creating such a department, which belongs to the management of all well-governed cities, must be recognized. London and Toronto are possibly two cities which have the best departments in this respect in Ontario. In street building, the object should not be so much to increase the expenditure of money, as to produce the most profitable results with the amount expended. The wisdom of a greater outlay to bring about a general improvement is best known to the taxpayers, but the

necessity for the best practise in the work which is being done, forms the greatest encouragement for more general outlay.

That you have taken up this question of streets for public discussion must be gratifying to your citizens, as a live, intelligent campaign for the best methods and workmanship in the construction, care and management of your streets is a matter of municipal economy in which every ratepayer should be interested.

These observations and this report is based upon my brief examination of this branch of your affairs, and I trust may be of some assistance to you in solving this vexed question.

I have the honor to be, gentlemen,

Your obedient servant,

(Signed) A. W. CAMPBELL,
Provincial Highway Commissioner.

Parliament Buildings, Toronto, Ont.
16th October, 1900.

Report of the City Engineer on Mr. Campbell's Report.

Winnipeg, Man., 19th November, 1900.

His Worship the Mayor and City Council, Winnipeg.

Gentlemen:—With reference to the report of Mr. A. W. Campbell, dated the 16th October, 1900:

Mr. Campbell visited Winnipeg last summer, and spent, it is understood, one or two days in the City. The weather had been dry for some time before his arrival, and he had no opportunity to see the effect of the Winnipeg mud on the streets.

Mr. Campbell's report is not correct in stating that his examinations were made in company with myself. With the exception of visiting the quarry at the same time as Mr. Campbell, and having about five minutes' conversation with him, I saw nothing of him. He did not visit my office nor ask for any plans, specifications or information with reference to the matter upon which he writes.

Apart from the short time given by Mr. Campbell to his investigation, his methods of obtaining information and arriving at conclusions would be considered among engineers as most superficial.

Mr. Campbell is mistaken in stating that business methods have not been employed in our street improvements. Also, in stating that we have not plans of the City, that levels have not been taken, and grades established. He is also wrong in stating that plans and specifications have not been prepared in accordance with the most modern practice.

Mr. Campbell is mistaken when he states that provision has not been made to drain and keep drained the sub-soil. Had he taken time to examine the records and plans in this office, he would have found that all pavements are thoroughly drained.

The following is a sample of the special pleading and apparent willingness to create unfavorable impressions, which characterize Mr. Campbell's report: "That you should have adopted asphalt, wood and macadam is an indication

"that your ideas are along the right line, but, on examining your work, it is clear that these ideas have not been carried into successful practice. The people are not receiving what they should reasonably hope for from their liberal expenditure."

He, however, acknowledges that: "The cedar blocks have been laid in the usual way, and, so far as this kind of pavement is useful, have given good service."

He says that, "In laying asphalt, much skill and care are required, and a full knowledge of how the material should be prepared and laid," which remark is, of course, quite correct, and will not be questioned by anyone. It might be added, however, that the same qualifications are necessary in reporting upon asphalt pavements.

Mr. Campbell says: "Where street railway tracks have to be dealt with, the result and experience of other plans should be consulted."

Had he condescended to ask in the Engineer's Department about this, he would have found that the original specification, a copy of which is attached, required brick between and alongside the rails, and that the Street Railway Co. were allowed to use the present rails and concrete at their own request and risk. All work in connection with the tracks and their maintenance being the concern of the Street Railway Co.

Mr. Campbell says: "To secure an even and uniform surface, the foundation must be thoroughly drained."

The foundations of all our pavements are thoroughly drained, but we find that other things are necessary to secure an "even and uniform surface."

"The present appearance of the asphalt indicates that you are commencing where other cities have ceased to experiment. In laying this very sensitive and costly pavement, drainage has been overlooked."

This is another deliberate mis-statement. Our specifications and manner of doing the work are most modern, and drainage has been most carefully attended to and secured. (See specification.)

Mr. Campbell then takes up the subject of macadam roads, and says:

"But the roadway is, in many respects, a striking exhibition of bad workmanship and improper methods. No proper foundation has been provided by drainage; much material has been used that is not worth hauling. Few of the streets are sufficiently crowned, many are irregularly crowned, and in places the surface is flat rather than crown-

"ed. Insufficient material has been used, and this has not been properly bonded. The principles of proper construction have not been observed in placing material," etc.

With reference to the above, as a matter of fact, every pavement has been drained by side drains under the curbs and by cross drains on the streets.

No stone was used that was not worth hauling. Mr. Campbell makes this sweeping assertion, because a little soft stone was for a time mixed with the better stone in the quarry, but as this was covered with the wearing surface of hard hornblendic rock, it will be found to give all the service expected from our limestone rock.

The streets when made are all sufficiently crowned to conform to the best practice and most approved methods. (See Mr. E. P. North's report on the Winnipeg specifications.)

The crown of the street has in no case been less than 6 inches, and it has been found that with any greater crown that that it is impossible to prevent ruts being formed by wheels. Where Mr. Campbell saw flat streets with varying surface, the defects were caused, as we in Winnipeg well know, by muddy wheels picking up and moving the stone in wet weather, and not by defects in the foundations, which, in all cases, remain intact until, as occurred on two or three streets, the whole of the surface was practically carried away by sticky clay on the wheels.

My reports for years have pointed this out and have indicated the remedy, in the extensions of pavement, in order to get rid of the mud.

The materials have been put on in two layers, and thoroughly rolled with heavy horse and steam rollers in the most approved manner.

Mr. Campbell states, as a defect of construction, "that material will be picked up by muddy wheels." Had he visited Winnipeg in a muddy season, he would have seen that no macadam can be built that will not be picked up by muddy wheels. I have seen more varieties of macadam roads and their wearing qualities than has Mr. Campbell, and I have never seen anything so destructive to macadam surface as Winnipeg mud.

Mr. Campbell then says: "The short life and imperfect service of these pavements, the cost of repairs and maintenance, will make them very expensive and unsatisfactory."

As a matter of fact, the average cost of repairs and maintenance on macadam streets in Winnipeg has been much less than is considered reasonable in places much more favorably situated than Winnipeg.

Referring to the lower formation in the quarry, Mr. Campbell says: "Unfortunately, this has been used largely "in the works of the past few years."

Mr. Campbell does not state that there are two classes of stone in the lower formation, and that, as far as possible, the soft stone was separated and wasted in the quarry. It was the expense of this separation which led me to ask the Works Committee to inspect the quarry last spring and ask for an appropriation to construct tracks on the higher level, where the stone is all of a hard nature.

Mr. Campbell says: "A considerable quantity of horn-blendic schist has been brought by rail from the vicinity of "Rat Portage, and used as a light surfacing coat. This is "not a first-class road material. It is not worth what it cost "the City. If material is to be brought by train for a long "distance, granite and trap rock, which can be secured in "large quantities in Northern Ontario, would prove a more "profitable investment."

In direct contrast to Mr. Campbell's opinion is that of Mr. North, who places this stone, in quality, between the best trap and the best granite—that it, second to the best.

Mr. Campbell, in a paper read at Ottawa, since his visit to Winnipeg, places road stones in the following order:

"The French Department of Public Highways has "adopted a scale of 0 to 20, showing the quality of different "kinds of stone. This list indicates:

Trap	varying from 16 to 20
Quartzile.	varying from 11 to 19
Quartz	varying from 10 to 18
Limestone	varying from 5 to 17
Gneiss	varying from 5 to 17
Granite	varying from 3 to 16

The hornblendic schist which we use is a Trappean rock, but, owing to its slightly schistose character, cannot be classed as the best. However, it will be seen, from the above table, that the poorest trap (and ours is not by any means poor), is as good as the best granite.

After quoting the above table, Mr. Campbell goes on to say to his Ottawa audience:

"These rocks are among the most common in Canada, and the list serves to show the wide degree to which their usefulness for road-making may vary. Limestone is most frequently criticized, but French practice shows that it may rank among the best; while granite, so frequently extolled, may be very poor, indeed."

And again: "Trap is universally regarded as very reliable, since it combines both toughness with fair cementing properties. The difficulty with granite, on the other hand, is that, while very hard, it wears into a coarse, sandy material, which refuses to bind."

From comparison of the above with the Winnipeg report, it appears that Mr. Campbell has more than one standard of road-making, and that the stone he places first in Winnipeg he places last in Ottawa.

Mr. Campbell then devotes several pages of his report to specifications and descriptions usually found in the technical works on pavements, which are very familiar to all engineers, and which generally represent the correct practice.

He gives a specification of macadam, which he recommends for Winnipeg, which differs from our present specifications only in the following particulars: 5 inches of flat stones is recommended for the bottom, and no hard stone is to be used for the wearing surface; side drains are to be 3 feet, instead of 2 feet, deep. He proposes to use for the wearing surface what Mr. North calls, and what we know from experience, to be an inferior stone. As Mr. North says, "it will neither wear nor bind well."

With reference to drainage, Mr. Campbell specifies: "Rows of 5-inch porous tile in the road-bed, 2 feet from each of the curb lines, these tiles to be laid 2 feet below the street grade, and have a regular and uniform fall into the catch-basins and outlets."

Reference to the Winnipeg specifications shows that it differs from the above in the following particulars:

The drains are made of coarse broken stone, instead of tiles. They are from 1 to $1\frac{1}{2}$ feet in depth, and they are located directly under the curb and gutter. This is much better practice than placing them 2 feet in on the roadway, so that water from the outside will have to run 2 feet under the road-way on each side before reaching the drains, whereas, in our system, the water is not allowed to reach the road-way at all. In addition to being practically more useful, our system is much cheaper than Mr. Campbell's.

We use broken stone drains here for two reasons. First, because it is cheaper than tile, while doing the work quite as well; and second, because tile drains near the surface of the ground are often destroyed by water freezing in them in the spring.

At a depth of 2 or 3 feet the ground is still frozen in June, so that up to that time the drains would be of no use, and just as soon as sufficient thawing takes place to allow the water to run into the tiles, it freezes there and destroys the pipe. It is, therefore, considered better to keep the drains nearer the surface, and to make them of indestructible material.

All our sub-grade drains are graded and drained into the catch-basins, under the wooden sluices, to which Mr. Campbell refers. Of course, he could not know this, as he did not ask.

Mr. Campbell objects to the short wooden sluices, which connect the pavement gutters with the catch-basins. Being built near the surface of the ground, the boxes may be readily renewed in twelve or fifteen years, if necessary. But there are special reasons for making these sluices of wood instead of tile, and for placing them near the surface of the ground, in order that they may carry off the early spring water, and they are made of wood because they are often choked with ice, which has to be cleaned out with a bar, and sometimes the cover has to be taken off to cut the ice out.

In addition to the side drains, cross drains are put in at distances apart of from 20 to 100 feet, as the nature of the case demands.

Mr. Campbell names some streets on which the surfacing is not as smooth as it should be. This is a defect which will be remedied as rollers can be spared from time to time. It is found that all the macadam requires surfacing two or three times before the bond will stand.

From the above it will be seen that Mr. Campbell is entirely at sea as to what has been done in sub-soil drainage, and, indeed, as to the whole matter.

With reference to prices, Mr. Campbell says: "The conditions being much similar, the prices prevailing in Toronto should be a fair estimate of the cost in Winnipeg."

He then proceeds to quote prices of asphalt and other pavements, forgetting that our asphalt is hauled 1,000 miles further than Toronto's, and that wages of all kinds are very much higher here. Even with these disadvantages, our pavements come well within the costs named by him.

Mr. Campbell winds up his statement by saying:

"That you have taken up this question of streets for public discussion must be gratifying to your citizens, as a live, intelligent campaign for the best methods and workmanship in construction, care and management of your streets is a matter of municipal economy in which every ratepayer should be interested."

Quite so, and had Mr. Campbell approached the subject in a business-like way, and studied it fully before committing himself to the sweeping incorrect statements made in his report, he might have been in a position to suggest something of value to the discussion.

I have never before seen what purports to be an engineering report, so superficial, so incorrect as to facts, and so entirely regardless of the ethics which, by common consent, govern matters of this kind.

Your obedient servant,

(Signed) H. N. RUTTAN,

City Engineer.